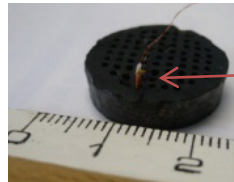


## Motivation

The experimental method for characterizing the magnetic properties of superconductors are based on bulk (susceptometry) or surface data (Hall probe mapping). However, the local magnetic properties in the volume are generally unavailable. The presence of holes inside drilled samples allows us to probe the magnetic field in the volume. In particular, we study the magnetic field penetration in the holes and compare it with usual characterization methods.

## Experimental setup



- The magnetic field is probed by **micro-coils** inserted in the holes

diameter of the micro-coil : 0.5 mm  
diameter of the wire : 50  $\mu$ m  
number of turns : 40

- An AC exciting field of high amplitudes is created in the **air gap** of an electromagnet.

Three 1000-turn coils wound on a sheeted iron core  
Compensation capacitor for the reactive power  
Power supply by an audio amplifier (30 Hz)

Calibration of the electromagnet

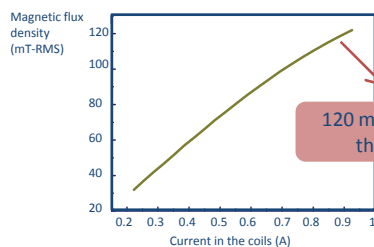


Fig. 1: Magnetic flux density in the air gap as a function of the current in the coil.

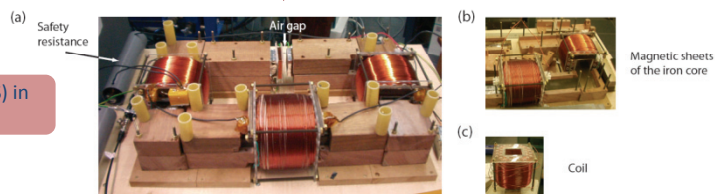
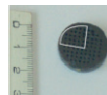


Fig. 2: (a)-Picture of the AC electromagnet capable of generating high amplitude AC magnetic fields in the air gap. (b)-Magnetic sheets of the iron core. (c)-One of the 1000-turn coils.

## Magnetic field inside the holes

- Analysis of the holes in one quarter of the sample

A uniform AC external magnetic field is increased from 30 mT to 120 mT. The field inside the holes is reported as a function of the exciting field.



4 different behaviours are observed

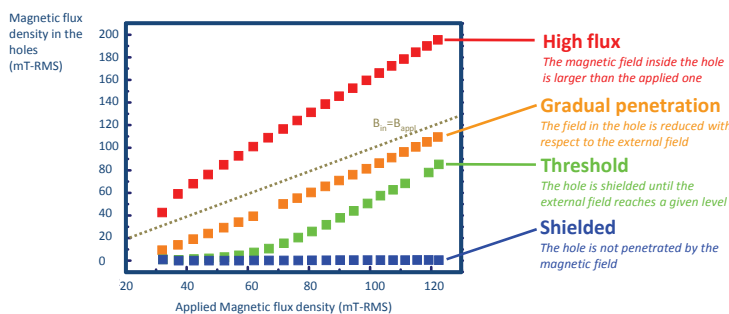


Fig. 3: Magnetic flux density (modulus of the fundamental component of the signal) in 4 different holes as a function of the applied field.

- Distribution of the hole behaviour in the quarter of the sample

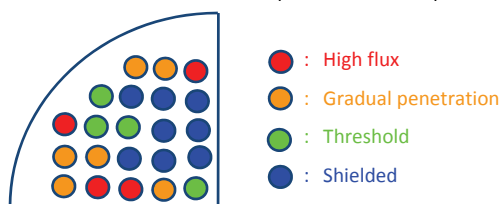


Fig. 4: Distribution of the behavior of the holes in one quarter of the sample.

## Comparison with Bean's model

- Simulation (Bean model) of the penetration of an AC magnetic field in an infinitely extended cylinder that has been drilled.

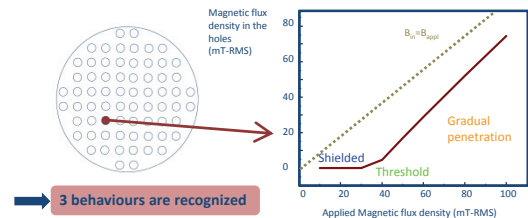


Fig. 5: Calculated magnetic field (Bean model) inside a hole of an infinitely extended drilled cylinder (left) as a function of the applied AC magnetic field.

## Comparison with the surface field

- Hall probe mapping of the penetration of the magnetic field

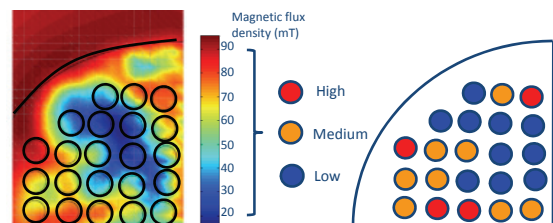


Fig. 6: Hall probe mapping in one quarter of the sample for an applied magnetic field of 90 mT (left) in comparison with the magnetic field measured in the hole (right).

## Conclusion

We have probed the magnetic field in the holes of a drilled sample. Four different behaviours have been observed. While the Bean model and Hall probe mapping only show magnetic shielding properties, we have demonstrated a flux concentration inside some holes.

## Acknowledgments

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